Chapter 5
System Selection

5-1. Corrosion Protection

Corrosion occurs on all metallic structures that are not adequately protected. The cost of replacing a structure which may have been destroyed or weakened due to excessive corrosion is substantial but avoidable, and means should be taken to prevent or mitigate this added cost through cathodic protection. In addition to preparing and applying protective coatings to the surface of a structure, a technique used to further prevent corrosion is to apply a protective current to the structure surface which contacts an electrolyte. This technique prevents or reduces the rate of surface corrosion by making the surface cathodic in the presence of other metals contacting the electrolyte.

5-2. Types of CPS's

a. Sacrificial CPS. This system helps reduce surface corrosion of a metallic structure immersed in an electrolyte by metallically coupling a less noble, i.e., more negative, metal with the structure. This system is based on sacrificing the more negative anodic metal to save the structure from deterioration by corrosion. Usually the anodic metals used are composed of zinc or magnesium.

b. Impressed current CPS. This system uses direct current applied to an anode system from an external power source to drive the structure surface to a state that is cathodic with respect to other metals in the electrolyte. Two types of anodes can be used; string anodes are installed either adjacent to or on the structure, and button anodes are installed on the structure. Both types must be isolated from the surface of the structure. Civil works systems are usually impressed current systems.

5-3. CPS Selection

When selecting which type of system to use, the designer should consider the size of the structure to be protected and past project experience in operating and maintaining both types of systems. Sacrificial anode systems on large structures such as gates deteriorate rapidly and become ineffective. However, a properly maintained impressed current system can last 10 to 30 years on the same structure.

a. Basis for selecting an impressed current system.

(1) Can be designed for a wider range of voltage and current applications.

(2) Higher ampere-years can be obtained from each installation.

(3) One installation can protect a more extensive area of the surface of the metallic structure.

(4) Voltage and current can be varied to meet changing conditions. This provides an operational flexibility that is very desirable to increase protection of the surface coating.

(5) Current requirement can be read and monitored easily at the rectifier.

(6) System can be used for protecting bare or poorly coated surfaces of metallic structures.

b. Basis for selecting a sacrificial anode system.

(1) External power source is not required.

(2) Installation is less complex since an external power source, including rectifier, is not required.

(3) This system works very well when resistivity is low, the structure is well coated, easy access to the structure is available, and significant deterioration of coating (paint) is not expected within 5 to 10 years.

(4) This system is easier to install on moving complex structures such as tainter valves where routing of cables from an impressed current system could present a problem.

c. Basis for not selecting a sacrificial anode system.

(1) Current output is limited. It has limited driving potential, therefore the protection for the bare steel area from each anode is limited.

(2) Sacrificial anode systems generally cannot be justified in water media when large surface areas of a poorly coated metallic structure require protection.

(3) Installation can be expensive. A greater amount of anode material is required due to the much higher anode consumption rates.

(4) Past experience has shown that as the protective coating deteriorates (or when surface areas of the metallic structure are physically scarred or scraped) more current and variations in current are required. The sacrificial anode system cannot respond to the additional bare area since its current and voltage are limited and cannot be varied.

(5) Due to the buildup of algae, silt, or other deposits on sacrificial anodes, the current output of the anode may be reduced.

(6) Basis of design must consider future and changing conditions of structure surface which is not considered in the design of sacrificial anode and impressed current systems.

(7) Although the sacrificial anode systems require less maintenance than impressed current systems, they nevertheless require some maintenance. Since there is no method to monitor a sacrificial anode system to determine if it is operating in accordance with NACE criteria, except by taking structure-to-electrolyte potential measurements, many times this type of system is neglected, resulting in damage to the structure.